# Soft Living Active and Adaptive Matter

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## How polymer-loop-extruding motors shape chromosomes

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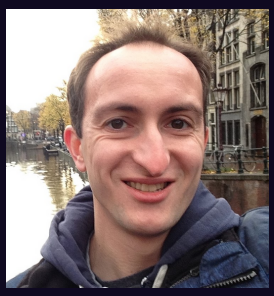
## Abstract:

Chromosomes are extremely long, active polymers that are spatially organized across multiple scales to promote cellular functions, such as gene transcription and genetic inheritance. During each cell cycle, chromosomes are dramatically compacted as cells divide and dynamically reorganized into less compact, spatiotemporally patterned structures after cell division. These activities are facilitated by DNA/chromatin-binding protein motors called SMC complexes. Each of these motors can perform a unique activity known as "loop extrusion," in which the motor binds the DNA/chromatin polymer, reels in the polymer fiber, and extrudes it as a loop. Using simulations and theory, I show how loop-extruding motors can collectively compact and spatially organize chromosomes in different scenarios. First, I show that loop-extruding complexes can generate sufficient compaction for cell division, provided that loop-extrusion satisfies stringent physical requirements. Second, while loop-extrusion alone does not uniquely spatially pattern the genome, interactions between SMC complexes and protein "boundary elements" can generate patterns that emerge in the genome after cell division. Intriguingly, these "boundary elements" are not necessarily stationary, which can generate a variety of patterns in the neighborhood of transcriptionally active genes. These predictions, along with supporting experiments, show how SMC complexes and other molecular machinery, such as RNA polymerase, can spatially organize the genome. More generally, this work demonstrates both the versatility of the loop extrusion mechanism for chromosome functional organization and how seemingly subtle microscopic effects can emerge in the spatiotemporal structure of nonequilibrium polymers.

**Date:**
**9/13/2021**

**Time:**
**9:00 AM-10:15 AM (PT)**

## About the speaker:



Dr. Edward Banigan is a postdoctoral associate working with Professor Leonid Mirny at the Massachusetts Institute of Technology. Previously, he did his Ph.D. in physics at the University of Pennsylvania, and he was a postdoc at Northwestern University.

Dr. Banigan is currently investigating the physical organization of the cell nucleus through simulations, theory, and bioinformatic analyses. In addition to studying the mechanisms of chromosome organization, he is interested in the mechanics, morphology, and dynamics of the cell nucleus as a whole, and how these properties may be controlled by genome biophysics.

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